DEEP WATER SKATES OF MADAGASCAR
PART 1

ANACANTHOBATIDAE (PISCES, CHONDRICHTHYES, BATOIDEA), SECOND RECORD OF THE SKATE *ANACANTHOBATIS ORI* (WALLACE, 1967) FROM OFF MADAGASCAR.

by

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RÉSUMÉ.– Au cours des campagnes de prospection pour la pêche crevettière effectuées par le Centre ORSTOM de Nosy-Bé (Madagascar), de 1971 à 1975, douze spécimens de raies ont été chalutés sur la pente continentale malgache (Collection A. Crosnier, partim). Deux spécimens sont à rapprocher de *Anacanthobatis ori* (Wallace, 1967) connue jusqu'à présent par ses spécimens-types (holo- et paratype) récoltés au large de l'Ile Bazaruto (Mozambique). *A. ori* est comparé aux différentes espèces d'Anacanthobatidae, décrites de l'Indo-Pacifique et de l'Atlantique Centre-Est.

La famille des Anacanthobatidae consiste en onze espèces nominales. Le statut taxinomique de cinq d'entre-elles est douteux, l'absence de matériel adéquat pour une étude comparative et l'insuffisance de certaines descriptions originales n'ayant pu permettre la détermination de ce statut. La liste des espèces nominales est établie, elle fournit les synonymies, les références bibliographiques et indique la localisation des spécimens-types.

L'aire de répartition des Anacanthobatidae est disjointe; ils sont présents dans l'Atlantique centre-ouest (Golfe du Mexique et Mer des Caraïbes), dans l'Océan Indien du sud-ouest (Afrique du Sud et Madagascar) et en Mer de Chine. Des hypothèses sont suggérées pour expliquer ce type de distribution.

ABSTRACT.– During the trawling survey for shrimp fisheries undertaken by the ORSTOM Center in Nosy-Be (small island of Madagascar) from 1971 to 1975, twelve specimens of deep water skates were collected off the West coast of Madagascar (part of A. Crosnier's collection). Two are referred to *Anacanthobatis ori* (Wallace, 1967), previously known only from the type-specimens (holo- and paratype) reported from off Bazaruto Island (Mozambique). *A. ori* is compared with its congeners so far described from the Indo-Pacific region and from the Western Central Atlantic.

Anacanthobatidae consist of eleven nominal species. The taxonomic status of five is doubtful, due to lack of adequate material for comparison and inaccuracy of some of the original descriptions. The list of the nominal species is given, including synonymies, literature references and data on type material.

Anacanthobatids exhibit a disjunct distribution, they occur within three well separated areas : western Central Atlantic (Gulf of Mexico and Caribbean Sea), south-western Indian Ocean (off South Africa and Madagascar), and China Sea. Hypotheses are suggested to explain such a distributional pattern.

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Anacanthobatidae, and its type-genus *Anacanthobatis*, were erected by von Bonde & Swart (1923) in emendation for their newly erected taxa Leiobatidae and *Leiobatis* respectively, which were preoccupied. They described two new species (*Anacanthobatis marmoratus* and *A. dubius*) but did not recognize them as skates (Rajoidei) and included their new family in the Masticura (= Myliobatidae). Barnard (1925) noticed that some characters of these new species could unite them with the Rajidae ; nevertheless, he re-assigned them to the family Dasyatidae, and was followed in this opinion by Fowler (1941) and Smith (1949). Bigelow & Schroeder (1951 to 1953), considering the nature of the pelvic fins, were convinced that the Anacanthobatidae represents a 'separate family among the rajoids'. In 1951 they erected a new genus (*Springeria*) for a new anacanthobatid (*Springeria folirostris*) from the Gulf of Mexico. The egg-capsule of *A. marmoratus* reported by Wallace (1967) corroborated Bigelow & Schroeder's 1951 opinion ; he described a further new species, *Springeria ori*, from off Southern Mozambique. The analysis of the clasper structure of *A. marmoratus* and *A. americanus*, and investigations on the type material of the nominal species known at that time, caused Hulley (1972, 1973) to propose a new taxonomic arrangement of the Anacanthobatidae. He recognized one genus only, *Anacanthobatis*, with four subgenera : *Anacanthobatis*, *Springeria*, *Sinobatis* n. subgen. and *Schroederobatis* n. subgen. Ishihara (1984) improved the description of *A. borneensis* with the aid of additional material from the East China Sea and commented on the questionable value of some characters such as the fusion of the pectoral axil with the outer margin of the posterior pelvic lobe and the fusion of the inner margin of this lobe with the root of the tail which he considered to be intraspecifically variable.

To date, eleven nominal species of anacanthobatid skates have been described, three from the western Central Atlantic (*A. folirostris* (Bigelow & Schroeder, 1951) ; *A. longirostris* Bigelow & Schroeder, 1962 ; and *A. americanus* Bigelow & Schroeder, 1962), and the remainder from the Indo-Pacific region (including : *A. marmoratus* von Bonde & Swart, 1923 ; *A. dubius* von Bonde & Swart, 1923 ; *A. ori* (Wallace, 1967) from the south-eastern coast of Africa and *A. borneensis* Chan, 1965b ; *A. melanosomus* (Chan, 1965a) ; *A nanhaiensis* (Meng & Li, 1981) ; *A. Stenosomus* (Li & Hu, 1982) from the South China Sea, and *A. donghaiensis* (Deng, Xiong & Zhan, 1983) from the East China Sea).

Material examined :

Anacanthobatis ori (Wallace, 1967) :

– MNHN n° 1985-394, juvenile male of 159 mm TL (including rostral filament), specimen n° 420 of Crosnier's collection, trawling survey of R.V. 'Vauban', NW Madagascar, haul n° 141, 13°40.3'S, 47°32.5'E, 1600-1725 m depth, 29 Feb. 1975, calcareous mud bottom.

– MNHN n° 1985-395, juvenile male of 111 mm TL (including rostral filament), specimen n° 530 of Crosnier's collection, trawling survey of R.V. 'Vauban', NW Madagascar, haul n°133, 13°02'S, 48°02'E, 1000-1525 m depth, 21 Jan. 1975, calcareous mud bottom.
– Holotype RUSI n° 8343 (previously ORI n° B 188), juvenile female of 206 mm TL (including rostral filament), trawled in 1509-1600 m depth (825-875 fms) east of Bazaruto Island (Mozambique), station n° 399C of R.V. 'Anton Bruun', 21°18'S - 36°18'E (see Hulley, 1973).

Anacanthobatis marmoratus von Bonde & Swart, 1923 :
– Lectotype RUSI n° 662, adult male of 232.9 mm TL (including rostral filament), trawled in 292.5 m depth (160 fms) off Natal (South Africa), station n° 152 of the S.S. 'Rickle', 30° 09.45'S - 30°58.02'E.
– RUSI n° 10430 (previously ORI n° B174), mature female of 242 mm TL (tail tip dammaged), trawled in 320 m depth (175 fms) off the Limpopo River mouth (Natal, South Africa), Sept. 1964 (see Wallace, 1967).

– FSFRL n° R241, adult male of 291.5 mm TL (including rostral filament), collected by otter trawl 'Akebonomaru' off Mozambique, 25°16'S - 34°29'E, 322 m depth, Dec. 3, 1970 (Isihara, pers. comm.). This specimen is illustrated in 'Colored Illustrations of Bottomfishes Collected by Japanese Trawlers', Vol. II, FSFRL (1976).
– FSFRL n° N904, adult female of 263 mm TL (including rostral filament), collected by otter trawl 'Akebonomaru' off Mozambique, 25°16'S - 34°24'E, 268 m depth, Nov. 23, 1970 (Ishihara, pers. comm.).

Anacanthobatis borneensis Chan, 1965b :
– Holotype BMNH n° 1965.1.29.1, mature male of 317 mm TL (excluding rostral filament), trawled in 834-823 m depth (436-450 fms), north of Kuching, Sarawak, Borneo (South China Sea), station n° 32 of the cruise 7/64 of the R.V. 'Cape ST. Mary', 6°01.8'N - 109°57.4'E, 5 Nov. 1964, soft mud bottom.
– THUP n° 03548, juvenile male of 207 mm TL (including rostral filament), collected from Tungkong (Taiwan), identified as *Springeria melanosoma*.
– THUP n° 03972, female of 280 mm TL (including rostral filament), collected from Tungkong (Taiwan), identified as *Springeria melanosoma*.
– SIO n° 70.274, female of 275.5 mm TL (including rostral filament), collected from Tungkong (Taiwan), identified as *Springeria melanosoma*. L. Chen coll.
– MTUF n° 25001, 25002, 25004 and 25005, see Ishihara (1984) for detailed data.

Anacanthobatis melanosomus (Chan, 1965a) .
– Holotype USNM n° 198.121, juvenile female of 121.7 mm TL (excluding rostral filament), trawled in 914-969 m depth (500-530 fms), south of Hong Kong (South China Sea), station n° 28 of the cruise 1/64 of the R.V. 'Cape ST. Mary', 19°20'N - 114°16'E, 7 Jan. 1964.

Institutional abbreviations :

BMHN = British Museum (Natural History) - London, England.
FSFRL = Far Seas Fisheries Research Laboratory - Shimizu, Japan.
ISH = Institut für Seefischerei - Hamburg, Western Germany.
MCZ = Museum of Comparative Zoology, Harvard University - Cambridge, U.S.A.
MNHN = Muséum National d'Histoire Naturelle - Paris, France.
MTUF = Museum of Tokyo University of Fisheries - Tokyo, Japan.
ORI = Oceanographic Research Institute - Durban, South Africa.
RUSI = J.L.B. Smith Institute of Ichthyology - Grahamstown, S. Afr.
SIO = Scripps Institution of Oceanography - La Jolla, U.S.A.
THUP = Tunghai University, Taichung - Taiwan, China.
USNM = United States National Museum - Washington D.C., U.S.A.

METHODS

Measurements were taken according to the method proposed by Hubbs & Ishiyama (1968). Those given in the original descriptions were utilized only when access to actual specimens was not possible ; if the measurements were not given in the original description, the author resorted to taking them from the illustrations.

Total length (TL) is measured from tip of tail to tip of snout, including the rostral filament. All but one author in the literature express the proportional measurements as a percentage of the TL, excluding the rostral filament.

Meristic counts of vertebrae, pectoral and pelvic radials were enumerated from radiographs. Tooth counts were taken from radiographs as well as from specimens when available. With regard to small specimens, it is more reliable to count the number of tooth rows from actual specimens than from radiographs.

DESCRIPTION OF THE MALAGASY SPECIMENS

For morphometric and meristic details see Tables I & V. In the figures given in the following description, disc and snout lengths include rostral filament.

External morphology (Fig. 1 to 4)

Disc somewhat pear-shaped, its width 1.1-1.2 greater than its length from base of rostral filament ; axis of maximum width at about 56 % of disc length. Snout short, its preorbital length 3.8-4.1 times as long as the interorbital distance, and blunt with an angle in front of spiracles of about 99°. Tip of snout marked off as a short triangular protuberance extending forward as a very thin and short rostral filament. Anterior margin of disc weakly undulated, almost straight at level of rostrum. Outer and inner pectoral corners broadly rounded and posterior pectoral margins strongly convex, pectoral axils almost entirely fused with the outer margin of the posterior pelvic lobes ; as a result the general outline of the posterior half of disc looks semi-circular. Anterior lobes of pelvic fins slender, leg-like and separate from posterior lobes. Posterior pelvic lobes fin-like, their inner margins completely fused along entire length with base of tail. Tail long, slender, whip-like and slightly depressed at level of base ; circular in cross-section at midlength and laterally compressed at level of caudal fin. Tail longer than trunk, i.e. length from middle of cloaca to tip of tail 1.7-1.8 times as long as length from middle of cloaca to base of rostral filament. The caudal fin consists of a long and low membraneous dorsal lobe, and a similar shorter (by one third) ventral lobe at the very end of the tail. No dorsal fins. No lateral tail folds. Orbits small, their horizontal diameter about 5.3-6.5 times in preorbital snout length ; interorbital distance about 1.4-1.6 times as long as orbit diameter. Spiracles very small, only half as long as the orbits. Eight pseudobranchial lamellae in each spiracle. Mouth almost straight ; upper jaw with 21-22 and lower jaw 18-21 tooth rows in a quincunx arrangement. Teeth with an irregular oval base and short posterior cusp (Fig. 3B). Anterior nasal lobes slightly fringed, posterior nasal curtains with fine lobelets on their rear margin and not overlapping the corners of the mouth (Fig. 3A).

Upper and lower surfaces of disc and the tail entirely naked. Upper surface with mucous pores and small fleshy papillae ; they are arranged more or less symmetrically and correspond to some of the lateral line system pores which open by way of these tubular papillae (Fig. 3 C).

Fig. 1.– *Anacanthobatis ori*, Malagasy specimen, MNHN nº 1985.394, juvenile male, 159 mm TL, in dorsal view.

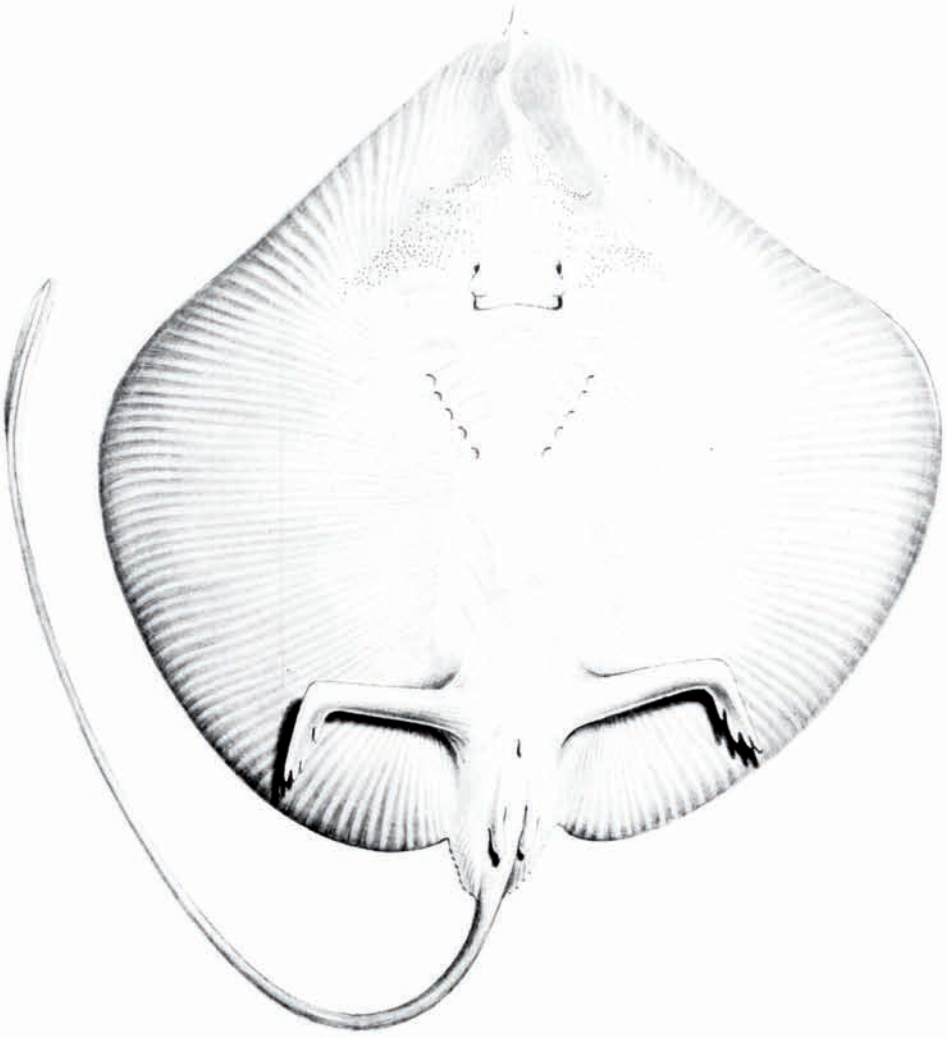

Fig. 2.– *Anacanthobatis ori,* Malagasy specimen, MNHN nº 1985.394, juvenile male, 159 mm TL, in ventral view.

Coloration (in alcohol)

Dorsal surface is uniformly medium brown, but lighter along median axis of trunk, and darker to posterior margins of disc and pelvic fins. Snout translucent. Papillae milky white. Orbits dark brown. Tail creamy white, somewhat brownish at base, and whitish towards tip; caudal fin whitish. Jaws and lips whitish. Anterior pelvic lobes creamy white, posterior pelvic lobes brownish with darker margins. Tail as described above. Claspers brownish.

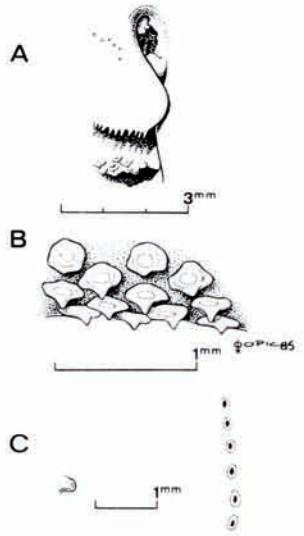

Fig. 3.– *Anacanthobatis ori*, Malagasy specimen, MNHN nº 1985.394 ; A, left nostril and mouth corner; B, teeth of left upper jaw; C, right scapular pores with one in lateral view.

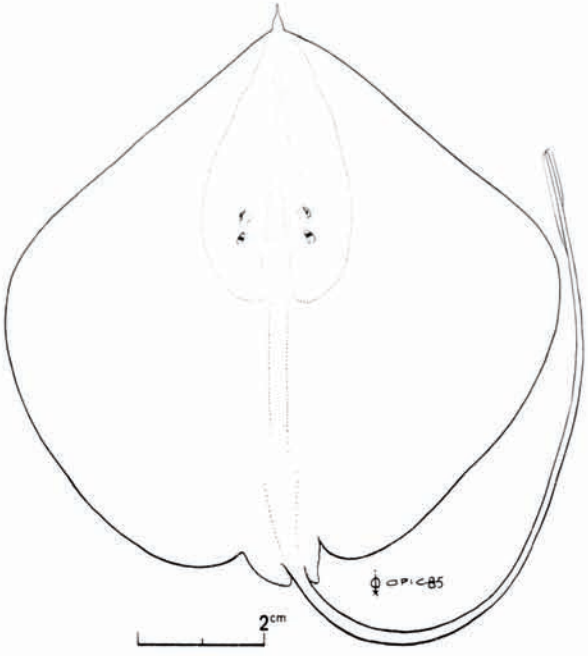

Fig. 4.– *Anacanthobatis ori*, holotype RUSI nº 8343, juvenile female, 206 mm TL (Wallace, 1967), in dorsal view showing pore pattern.

Pelvic girdle (Fig. 5 & Table III)

Observations based on radiographs. The pelvic girdle of *Anacanthobatis ori* is lyre-shaped, with a relatively thick puboischiadic bar, concave anteriorly and posteriorly ; the prepelvic processes are long and slender, lightly curved with the distal ends outwardly inclined; the iliac processes are short, finger-like and anteromedially oriented ; there is a single large obturator foramen.

In the Anacanthobatidae, both the pelvic and the pectoral girdles are sexually dimorphic (Hulley, 1973). The two juvenile males of *A. ori* have a pelvic bar more deeply concave anteriorly than in the juvenile female ; and the propterygia of their pectoral girdle consist of two articulated segments vs. one single element in the female (Fig. 6).

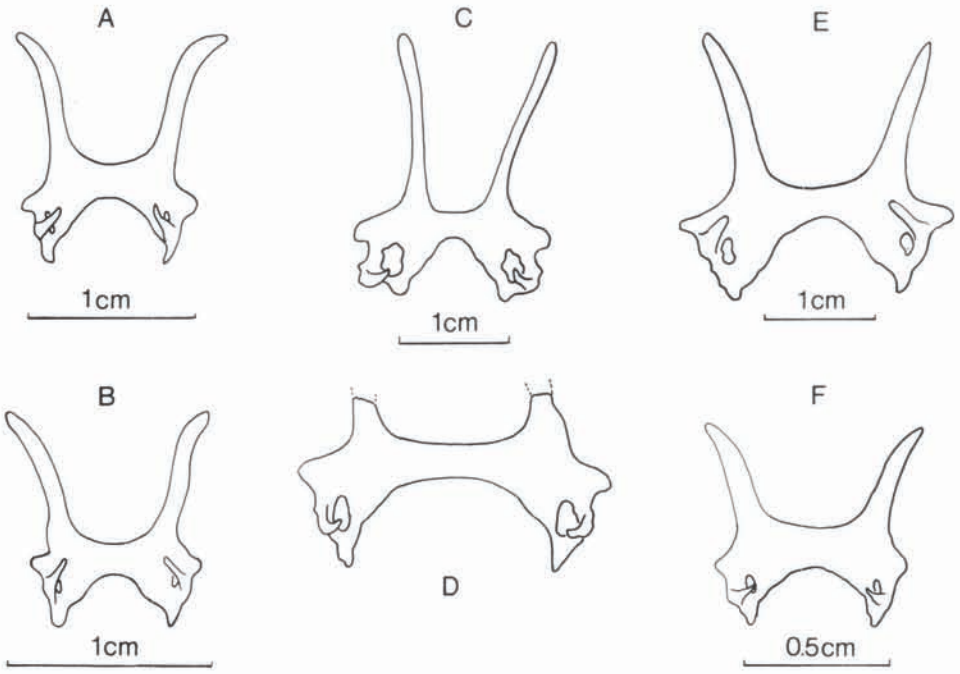

Fig. 5.– Pelvic girdles : A, *Anacanthobatis ori*, holotype RUSI nº 8343 (juvenile female) ; B, *A. ori*, MNHN nº 1985.394 (juvenile male) ; C, *Anacanthobatis marmoratus*, lectotype RUSI nº 662 (adult male) ; D, *A. marmoratus*, RUSI nº 10430 (adult female) ; E, *Anacanthobatis borneensis*, holotype BMNH nº 1965.1.29.1 (adult male) ; F, *Anacanthobatis melanosomus*, holotype USNM nº 198.121 (juvenile female). Tracing made from radiograph with a drawing-tube.

Neurocranium (Fig. 7 & Table IV) :

Study based on a combination of direct observations of the three specimens of *Anacanthobatis ori* aided by the use of radiographs.

The neurocranium of *A. ori* has a long, slender, triangular rostral base extended anteriorly as a very thin and delicate rostral shaft falling short of the level of the

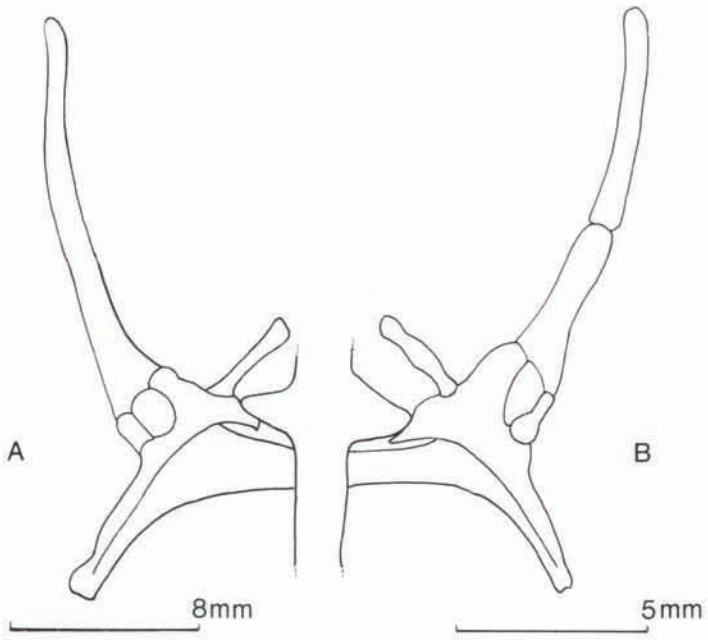

Fig. 6.– Pectoral girdle of *Anacanthobatis ori* : A, holotype, RUSI n° 8343 (juvenile female); B, MNHN n° 1985.395 (juvenile male). Tracing made from radiograph with a drawing-tube.

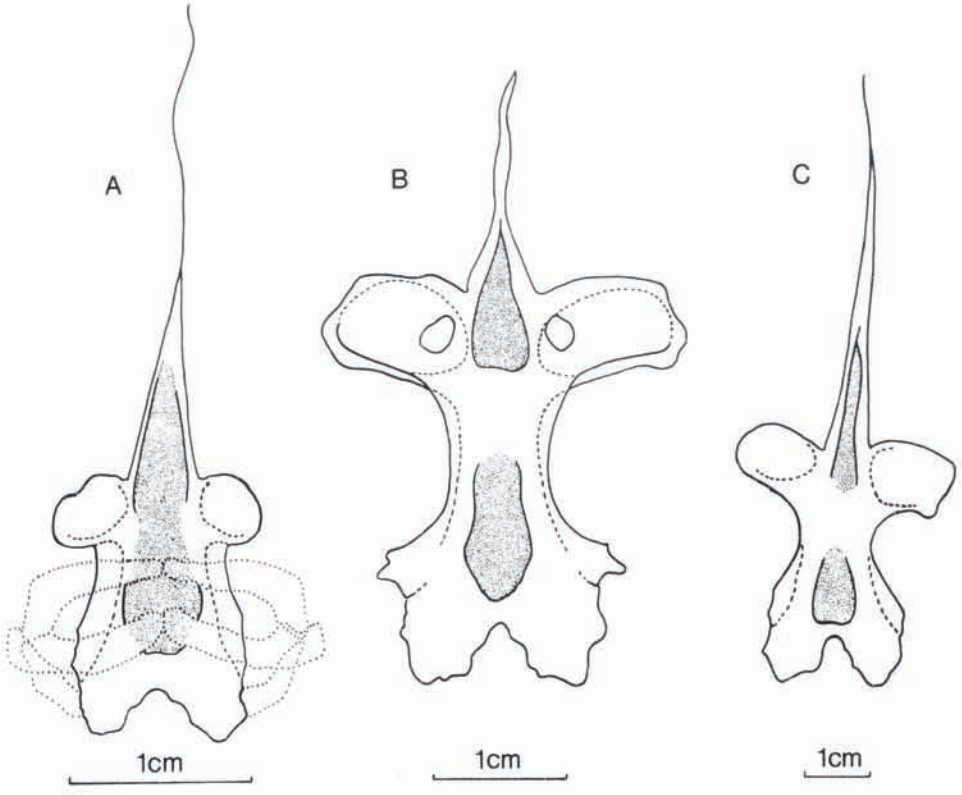

Fig. 7.– Neurocrania : A, *Anacanthobatis ori*, holotype RUSI n° 8343 ; B, *Anacanthobatis marmoratus*, lectotype RUSI n° 662 ; C, *Anacanthobatis borneensis*, holotype BMNH n° 1965.1.29.1. Tracing made from radiograph with a drawing-tube.

most anterior pectoral radials ; the length of the rostral cartilage is about 70 % of the cranial length. The rostral node and appendices are not distinguishable on radiographs and could not be revealed by partial dissection. There is a single large fontanelle lightly constricted along mid-length, the anterior part is tapered and the posterior part bulbous ; it is likely that adults would exhibits two well separated fontanelles as observed in *A. marmoratus*. The nasal capsules are small, ovoid-shaped, not bulging into the procerebral space and set at about 90° to the longitudinal axis of the neurocranium. No basal fenestra is distinguishable, neither on the radiographs nor on the examined specimens of *A. borneensis*, whilst both specimens of *A. marmoratus* show a well outlined fenestra in each nasal capsule. Both the interorbital space and the least width of the basal plate are relatively broad, at about 62 % and 53 % of the cranial width, respectively.

INTERSPECIFIC COMPARISONS (TABLES I TO VI)

Confirmation of the identify of *Anacanthobatis ori* is problematic since only four juvenile specimens are available. Nevertheless, *A. ori* is tentatively retained as a distinct species on the basis of the following differences :

– In relation to its only sympatric congener (i.e. *Anacanthobatis marmoratus*) : *A. ori* has a longer tail (tail 1.5 to 1.7 times as long as trunk versus 1.0-1.1 for *A. marmoratus*) ; a smaller eye (orbit diamerter about 8 times interorbital distance vs. 3-4 times) ; an apparently lower tooth count (24/23 vs. 28-32/29-31) ; and a different coloration of the dorsal side (brownish without any patterning vs. mottled light brown), nasal capsule (lacking basal fenestra vs. possessing basal fenestra). Hulley (1973) indicates the nasal curtain is overlapping the corner of the mouth in *marmoratus*, and not overlapping in *ori*, but this character does not seem justified after the inspection of the specimens.

– In relation to the species of the western Central Atlantic : none of the three species reported from this area has any dermal papillae on the dorsal surface of the disc. In addition, *Anacanthobatis folirostris* is well set apart from all its congeners in possessing a leaf-like expansion at the tip of the snout ; *Anacanthobatis longirostris* presents the longest snout, its preorbital length is about 9 times as long as the interorbital distance compared with less than 8 times as long for the other species. *Anacanthobatis americanus* is distinct from *A. ori* in having a bigger eye, its diameter is 1.3-1.8 times as long as the interorbital distance compared with an interorbital distance 1.4-1.6 times as long as orbit diameter.

– In relation to the species of the South and East China Seas :

In *A. borneensis* the trunk is longer than the tail ; distance from middle of cloaca to base of rostral filament is 1.3-1.4 times as long as distance from middle of cloaca to tip of tail, compared with a tail 1.5-1.7 times as long as the trunk in *A. ori*.

Anacanthobatis melanosomus appears to resemble *A. ori*, but both are only known from juveniles, and adult specimens are needed, particularly mature males, to confirm its validity. Nevertheless, *A. melanosomus* shows 6 minute denticles along the midline of the base of the tail, a character that it seems share with *A. folirostris* juvenile stages (Chan, 1965a). Ishihara (1984) stated that the morpho-

metric differences between *A. borneensis* and *A. melanosomus* are intraspecific variations ; the specimens studied and identified as *A. melanosomus* by Chen & Chung (1971) corroborate his opinion.

Anacanthobatis nanhaiensis is the only anacanthobatid without a terminal rostral filament, the original description states « the snout is not produced in filament », and neither the illustrations of the holotype (adolescent male of 295 mm TL), nor the one of the paratype (female of 236 mm TL) show any rostral filament. A character that would modify the diagnosis of the family if confirmed. Nevertheless, Ishihara (1984) pointed out the close similarity between *A. borneensis* and *A. nanhaiensis* and he suggested the validity of *A. nanhaiensis* was doubtful.

Anacanthobatis stenosomus and *A. donghaiensis* are also very similar to *A. borneensis.* For the moment, they are retained as separate species only because the types were not available to the present author, and that the original descriptions do not permit meaningful comparisons to be made.

The taxonomic status of five out of the eleven nominal species remains doubtful due to the lack of material for useful comparisons and the limited data available in their original descriptions. Hence, at the present time only the following checklist of the anacanthobatid skates can be proposed :

ANACANTHOBATIDAE

Anacanthobatis von Bonde & Swart, 1923 — Gender : M

Rep. Fish mar. biol. Surv. Un. S. Afr. 3 (Spec. Rep. 5) : 18, emendation for *Leiobatis* preoccupied (on an attached errata slip).

Type species : *Anacanthobatis marmoratus* von Bonde & Swart, 1923 (by original designation).

Note : In the literature, von Bonde & Swart's paper is sometimes dated 1923 and sometimes 1924. The errata slip which is closely bound to a reprint of the original publication does not present any date, but since the date of publication is specified (« issued 25th August 1923 ») on the cover of the reprint and page 22, the correct year of publication for von Bonde & Swart's work is 1923 according to article 21 of the International Code of Zoological Nomenclature.

Anacanthobatis von Bonde & Swart, 1923 (subgenus of Hulley, 1973).

Springeria Bigelow & Schroeder, 1951 : 111 (type-species : *Springeria folirostris* Bigelow & Schroeder,1951 ; subgenus of Hulley, 1973).

Sinobatis Hulley, 1973 : 153 (subgenus, type-species : *Anacanthobatis borneensis* Chan, 1965b).

Schroederobatis Hulley, 1973 : 154 (subgenus, type-species : *Anacanthobatis americanus* Bigelow & Schroeder, 1962).

Anacanthobatis (Anacanthobatis) marmoratus von Bonde & Swart, 1923

Anacanthobatis marmoratus von Bonde & Swart, 1923 : 18, pl. xxiii, emendation for *Leiobatis marmoratus,* preoccupied (off Natal, South Africa). Lectotype : RUSI n° 662, adult male 232.9 mm TL (including rostral filament).

Anacanthobatis marmoratus : Barnard, 1925 : 79 - Fowler, 1941 : 448 - Smith, 1949 (1977) : 71, fig. 84 - Bigelow & Schroeder, 1953 : 327 (footnote 28) - Bigelow & Schroeder, 1962 : 217 (key only) - Chan, 1965b : 46 (key only) - Wallace, 1967 : 43, fig. 22-23 - Hulley, 1972 : 5, fig. 2g-h (pelvic girdle), 14 fig. 10 (clasper anatomy), 33 fig. 17g (dtl carti-

Table 1.– *Anacanthobatis ori*, measurements expressed in mm and as a percentage of the total length.

	MNHN 1985.394		MNHN 1985.395		RUSI 8343		Data from Wallace (1967) Holotype		Paratype	
	mm	%	mm	%	mm	%	mm	%	mm	%
Total length (TL)	159.0		111.0		198.0		206	100.0	145	100.0
TL to base of rostral filament	157.8	100.0	109.5	100.0	196.5	100.0				
Length of rostral filament	1.2	0.8	1.5	1.4	1.5	0.8				
Disc width	71.0	45.0	52.0	47.5	92.0	46.8	102	49.5	70	48.3
Disc length	65.0	41.2	43.0	39.3	89.0	45.3	93	45.1	62	42.8
Snout to max. disc width	38.0	24.1	28.0	25.6	47.0	23.9	52	25.2	34	23.4
Preorbital snout length	20.9	13.2	15.4	14.1	35.0	17.8	36	17.5	23	15.9
Prenasal snout length	21.0	13.3	15.4	14.1	34.5	17.6				
Preoral snout length	23.7	15.0	17.5	16.0	37.5	19.1	42	20.4	26	17.9
Snout to cloaca	58.0	36.8	39.5	36.1	77.0	39.2	82	39.8	53	36.6
Cloaca to tip of tail	101.0	64.0	71.5	65.3	121.0	61.6				
Head length ventrally	36.0	22.8	25.5	23.3	53.0	27.0				
Orbit diameter	3.2	2.0	2.9	2.6	4.1	2.1				
Spiracle length	1.6	1.0	1.0	0.9	1.7	0.9				
Orbit + spiracle length	5.3	3.4	4.2	3.8	6.5	3.3				
Interorbital distance	5.1	3.2	4.0	3.7	6.1	3.1	8	3.9	5	3.4
Interspiracular distance	8.4	5.3	6.2	5.7	8.4	4.3	11	5.3	9	6.2
Internasal distance	5.7	3.6	4.0	3.7	6.4	3.3				
Mouth width	7.2	4.6	5.1	4.7	8.2	4.2	7	3.4	6	4.1
Between 1st gill slits	15.0	9.5	9.9	9.0	19.8	10.1	20	9.7	14	9.7
Between 5th gill slits	8.0	5.1	6.3	5.8	10.0	5.1	13	6.3	10	6.9
First gill slit length	0.8	0.5	0.5	0.5	1.0	0.5				
Third gill slit length	0.9	0.6	0.5	0.5	1.2	0.6				
Fifth gill slit length	0.8	0.5	0.5	0.4	0.9	0.4				
Length of ant. pelvic lobe	22.3	14.1	15.4	14.1	26.0	13.2	30	14.6	20	13.8
Length of post. pelvic lobe	17.5	11.1	10.5	9.6	23.0	11.7				
Tail at pelvic tips, height	1.4	0.9	1.2	1.1	2.0	1.0				
Tail at pelvic tips, width	1.5	1.0	1.4	1.3	2.0	1.0				
Tail in front of caudal, height	0.7	0.4	0.6	0.5	1.0	0.5				
Tail in front of caudal, width	0.5	0.3	0.5	0.5	0.9	0.4				
Nasal curtain, length	3.3	2.1	2.1	1.9	4.0	2.0				
Nasal curtain, width each lobe	2.1	1.3	1.1	1.0	2.6	1.3				
Nasal curtain, between lobes	3.3	2.1	2.3	2.1	3.8	1.9				
Upper caudal lobe, length	20.5	13.0	12.0	11.0	16.5	8.4				
Upper caudal lobe, height	0.3	0.2	0.2	0.2	0.8	0.4				
Lower caudal lobe, length	14.4	9.1	4.5	4.1	9.5	4.8				
Lower caudal lobe, height	0.2	0.1	0.2	0.2	0.6	0.3				
Clasper, postcloacal length	7.0	4.4	4.3	3.9						

Table II.– Anacanthobatids proportional measurements ; data from the literature (1), from reinvestigated actual specimens (2) and from original illustrations (3).

	A. folirostris			A. longirostris		A. americanus			A. marmoratus			A. borneensis			A. melanosomus			A. nanhaiensis	A. stenosomus
	1	1	3	1	3	1	1	3	1	2	2	1	2	3	1	3	2	3	3
Disc length	55.3	57.2	6.2	66.4	66.5	57.0	55.7	56.7	56.7	57.2	60.0	59.0	66.3	67.3	48.0	48.6	44.9	66.3	64.6
Disc width	51.6	53.3		56.8	58.1	58.5	58.6	56.1	66.1	64.8	67.1	66.2	65.0	65.3	49.0	50.0	48.1	67.3	56.1
Preorbital length	21.8	22.4	21.6	29.8	30.4	19.3	17.4	18.1	13.5	13.5	14.7	24.6	24.3	25.6	17.0	16.8	13.0	25.0	23.8
Prenasal length			23.1					19.4	1.5	11.8	12.2		23.0	24.1		16.8	13.1	24.0	23.8
Preoral length	24.3	24.3	26.3	32.8				21.7	3.6	14.8	15.8	25.2	24.6	26.6	19.0	18.6	15.2	26.4	26.1
Head length			34.4					31.7		28.7	27.3		38.5	40.2		25.6	23.1	37.5	35.4
Snout to cloaca	47.6	50.0	50.9	57.4		46.6	46.0	45.6	48.3	48.1	50.3	58.4	56.5	58.8	40.0	39.6	36.1	57.7	56.1
Cloaca to tip of tail	52.4	50.0	49.1	42.6		53.4	54.0	54.4	51.7	51.1	49.7	44.2	43.5	41.2	60.0	60.4	63.9	42.3	43.8
Orbit diameter	2.9	3.3	3.7	3.2	3.4	4.0	4.0	3.9	3.2	4.7	4.2	2.3	3.7	3.7	1.0	2.4	3.1	2.9	2.9
Spiracle	1.0	1.5	1.3	1.4	1.4	1.2	1.4	1.7	1.9	1.8	1.8	1.1	1.3	1.0	1.0	0.6	0.8	1.2	1.5
Interorbital width	2.6	2.6	2.5	3.3	3.4	3.0	2.2	2.5	3.5	3.7	5.1	3.5	3.5	4.0	5.0	6.0	4.5	3.4	4.8
Interspiracular width	5.1	5.0	5.0	5.3	6.5	6.4	6.0	5.3		8.1	9.3	6.9	6.6	6.5	6.0	8.0	6.3	6.1	6.5
Internasal width	3.8	4.0	4.1	4.8		3.6	4.0	4.2	6.7	6.3	6.8	6.2	6.0	5.8	4.0	3.0	3.7	4.5	3.9
Mouth width	4.5	4.8	4.4	4.9		4.5	5.8	6.1	8.5	7.8	7.0	6.6	6.6	7.5	5.0	4.4	4.7	5.7	5.7
Between 1st gill slits	9.2	10.5	9.4	10.1		11.6	10.7	10.0	12.4	12.5	15.2	11.4	13.6	13.3	10.0	10.4	9.4	13.0	12.5
Between 5th gill slits	4.8	5.6	4.7	7.1		6.1	5.1	4.4	6.9	6.5	7.6	6.8	6.5	4.5	5.0	6.4	4.8	6.0	6.9

Table III.– Proportional measurements of anacanthobatid pelvic girdles expressed in mm and as a percentage of the maximum width (from radiographs).

	A. ori RUSI n°8343		A. ori MNHN 1985.394		A. marmoratus RUSI n°662		A. borneensis BMNH 65.1.29.1		A. melanosomus USNM 198.121	
	mm	%	mm	%	mm	%	mm	%	mm	%
Maximum width	10.5	100%	8.4	100%	17.8	100%	24.9	100%	13.2	100%
Total length	13.5	128.6	10.3	122.6	23.4	131.5	23.4	94.0	13.5	102.3
Length of prepelvic process	10.1	96.2	7.2	85.7	18.0	101.1	16.2	65.1	9.4	71.2
Length of postpelvic process	3.5	33.3	3.0	35.7	5.4	30.3	7.2	28.9	4.1	31.1
Median depth of anterior arc	7.7	73.3	6.3	75.0	16.1	90.4	13.7	55.0	7.0	53.0
Median depth of posterior arc	3.9	37.1	2.5	29.8	5.4	30.3	7.1	28.5	4.1	31.1
Transverse length of central bar	1.9	18.1	1.4	16.7	2.0	11.2	2.7	10.8	2.4	18.2
Diameter of foramen	1.1	10.5	0.7	8.3	2.9	16.3	2.2	8.8	0.9	6.8

Table IV.– Proportional measurements of anacanthobatid neurocrania expressed in mm and as a percentage of the nasobasal length (from radiograph).

	A. ori RUSI n°8343		A. marmoratus RUSI n°662		A. borneensis BMNH n°65.1.29.1	
	mm	%	mm	%	mm	%
Nasobasal length (mm)	11.5	100%	23.5	100%	28.7	100%
Cranial length	37.5	326.1	42.0	178.7	88.3	307.7
Rostral cartilage length	26.0	226.1	16.5	70.2	59.6	207.7
Cranial width	11.6	100.9	27.8	118.3	35.7	124.4
Interorbital width	7.2	62.6	7.3	31.1	11.7	40.8
Rostral base	4.0	34.8	5.1	21.7	7.2	25.1
Anterior fontanelle length			11.4	48.5	26.1	90.9
Anterior fontanelle width			4.1	17.4	3.9	13.6
Posterior fontanelle length			8.8	37.4	8.3	28.9
Posterior fontanelle width			5.1	21.7	6.5	22.6
Width across otic capsules	9.3	80.9	15.5	66.0	22.2	77.4
Least width of basal plate	3.9	33.9	5.3	22.6	8.7	30.3

Table V.– Anacanthobatid meristics.

	A. marmoratus		A. ori			A. borneensis	A. melanosomus
	RUSI n°662 Lecto.	RUSI 10430	RUSI 8343 Holo.	MNHN 85.394	MNHN 85.395	BMNH 65.1.29.1 Holo.	USNM 198121 Holo.
Tooth rows, upper jaw	28	32	24	22	21	25	23
Tooth rows, lower jaw	29	31	23	21	18	26	23
Trunkal vertebrae	24	25	26	25	23	28	28
Pectoral radials:							
Propterygium	30-30	32-32	27-27	27-26	25-25	28-27	24-24
Intercalary	5-5	3-3	3-3	3-4	4-4	4-5	5-5
Mesopterygium	11-11	13-12	13-13	13-12	13-13	15-15	15-15
Metapterygium	30-30	28-29	27-27	28-29	31-30	29-28	31-31
Total number	76-76	76-76	70-70	71-71	73-72	76-75	75-75
Pelvic radials:							
Anterior lobe	3-3	3-3	3-3	3-3	3-3	3-3	3-3
Posterior lobe	12-12	14-14	14-14	10-10		11-11	14-14
Total number	15-15	17-17	17-17	13-13		14-14	17-17

Table VI.– Anacanthobatid meristics using data from literature : tooth counts from original descriptions; radial numbers from Hulley (1973).

	A. folirostris	A. longirostris	A. americanus	A. nannaiensis	A. stenosomus
Tooth rows, upper jaw	22-30	28	25-24	28	22
Tooth rows, lower jaw	22-28	27	21-24	34	
Pectoral radials	87-89	88-90	66		
Pelvic radials	16-19	14-19	12		

lage), 35 fig. 19f (dt2 cartilage), 36 fig. 20k (dt3 cartilage), 40 fig. 23 d (Vt cartilage), 42 fig. 25d (at1 cartilage), 44 fig. 27d (at2 cartilage), 53 fig. 43 (cartilages of right clasper), 79, 83 and 97 (phyletic relationship) - Hulley, 1973 : 133, fig. 1A, B (lectotype designation and redescription).

Anacanthobatis (Anacanthobatis) marmoratus : Hulley, 1973 : 153 (introduction and definition of subgenus *Anacanthobatis*).

Anacanthobatis dubius : von Bonde & Swart, 1923 : 19 - Barnard, 1925 : 80 - Wallace, 1967 : 43.

Leiobatis marmoratus : Fowler, 1941 : 448.

Leiobatis dubius : Fowler, 1941 : 448.

Springeria dubia : Bigelow & Schroeder, 1953 : 328 (key), 327 (footnote 28) - Zhu et al., 1981 : 115 - Deng et al., 1983 : 217.

Anacanthobatis (Springeria) folirostris (Bigelow & Schroeder, 1951)

Springeria folirostris Bigelow & Schroeder, 1951 : 112, fig. 1 (Gulf of Mexico, off the Mississipi River).

Holotype : USNM n° 152546, immature male 422 mm TL (including rostral filament).

Springeria folirostis : Bigelow & Schroeder, 1953 : 328, fig. 78a - Bigelow & Schroeder, 1965 : 472, fig. 9 - Chan, 1965a : 40-44 (comparison with *melanosomus*) - Wallace, 1967 : 46 (key, distinctive characters) - Bigelow & Schroeder, 1968 : 20 - Zhu et al., 1981 : 115 (comparison with *nanhaiensis*) - Zhu et al., 1982 : 311 (comparison with *stenosomus*) - Deng et al., 1983 : 217.

Anacanthobatis (Springeria) folirostris : Hulley, 1973 : 153 (introduction and definition of subgenus *Springeria*).

Anacanthobatis (Schroederobatis) americanus Bigelow & Schroeder, 1962

Anacanthobatis americanus Bigelow & Schroeder, 1962 : 217, fig. 14-16 (Atlantic coasts of Central and South America).
Holotype : USNM nº 196445, female 337 mm TL (excluding rostral filament).
Anacanthobatis americanus Bigelow et Schroeder, 1965 : 469, fig. 7 - Chan, 1965b : 46 (key) - Wallace, 1967 : 44 (key, distinctive characters) - Bigelow & Schroeder, 1968 : 18 - Hulley, 1972 : 8 fig. 4e (pelvic girdle), 15 fig. 11 (clasper anatomy), 29 fig. 15e (proximal segments of claspers), 33 fig. 17h (dtl cartilage), 35 fig. 19g (dt2 cartilage), 42 fig. 25e (atl cartilage), 44 fig. 27e (at2 cartilage), 53 fig. 44 (clasper cartilages) - Cuzman, 1978 : 139 (new record).
Anacanthobatis (Schroederobatis) americanus : Hulley, 1973 : 154 (introduction and definition of subgenus *Schroederobatis*) -
Anacanthobatis americana : Uyeno, Matsuura and Fujii (eds), 1983 : 79, fig.

Anacanthobatis (Springeria) longirostris Bigelow & Schroeder, 1962

Anacanthobatis longirostris Bigelow & Schroeder, 1962 : 223, fig. 17-18 (Gulf of Mexico, off Mississipi Delta).
Holotype : USNM nº 196446, female 507 mm TL (excluding rostral filament).
Anacanthobatis longirostris : Bigelow & Schroeder, 1965 : 470, fig. 8 - Chan, 1965b : 47 (key) - Wallace, 1967 : 44 (key, distinctive characters) - Bigelow & Schroeder, 1968 : 19 - Guzman, 1978 : 140.
Anacanthobatis (Springeria) longirostris : Hulley, 1973 : 153 (listed).

Anacanthobatis melanosomus (Chan, 1965a)

Springeria melanosoma Chan, 1965a : 40, fig. 1-2 (off Hong-Kong, South China Sea).
Holotype : USNM nº 198121, young female 121.7 mm TL (excluding rostral filament).
Springeria melanosoma : Wallace, 1967 : 46 (key and distinctive characters) - Zhu *et al.*, 1981 : 115 (comparison with *manhaiensis*) - Zhu *et al.*, 1982a : 311 (comparison with *stenosomus*) - Zhu *et al.*, 1982b : 86 (listed) - Deng *et al.*, 1983 : 217 (comparison with *donghaiensis*).
Anacanthobatis (? Sinobatis) melanosomus : Hulley, 1973 : 153 (listed) - subgenus questionable since no adult male is available.
Anacanthobatis melanosoma : Ishihara, 1984 : 449 (comparison with *borneensis*).

Anacanthobatis (Sinobatis) borneensis Chan, 1965b

Anacanthobatis borneensis Chan, 1965b : 47, fig. 1-2 (off Borneo, South China Sea).
Holotype : BMNH nº 1965.1.29.1, mature male 317 mm TL (excluding rostral filament).
Anacanthobatis borneensis : Wallace, 1967 : 43 (key and distinctive characters) - Zhu *et al.*, 1982b : 86 (listed) - Ishihara, 1984 : 448, fig. 1 - Okamura & Kitjima, 1984 : 69 (in Japanese), 309 (in English), fig. 36 - Masuda *et al.*, 1984 : 14, pl. 16G.
Anacanthobatis (Sinobatis) borneensis : Hulley, 1973 : 153 (introduction and definition of subgenus *Sinobatis*).
Springeria melanosoma : Chen & Chung, 1971 : 26, fig. 19 (Taiwan).

Anacanthobatis ori (Wallace, 1967)

Springeria ori Wallace, 1967 : 46, fig. 24 (off Bazaruto Island, Mozambique).
Holotype : RUSI nº 8343 (ex. ORI nº B 188), young female 206 mm TL (including rostral filament).
Anacanthobatis (? Anacanthobatis) ori : Hulley, 1973 : 153 (listed - subgenus questionable since no adult male is available).
Anacanthobatis ori : Ishihara, 1984 : 449 (listed).

Anacanthobatis nanhaiensis (Memg & Li, 1981)

Springeria nanhaiensis Meng & Li, 1981 : 105 (in Chinese), 115 (in English), fig. 2 (South China Sea).

Holotype : S. China Sea Fish. Res. Inst. (Kuang-Chou) n° S 04915, male 295 mm TL (no rostral filament).

Springeria nanhaiensis : Zhu *et al.*, 1982 : 311 (comparison with *stenosomus*) - Deng *et al.*, 1983 : 217 (comparison with *donghaiensis*).

Anacanthobatis nanhaiensis : Ishihara, 1984 : 449 (listed).

Anacanthobatis stenosomus (Li & Hu, 1982)

Springeria stenosoma (Li et Hu, 1982 : 306 (in Chinese), 310 (in English), fig. 5 (South China Sea).

Holotype : S. China Sea Fish. Res. Inst. (Kuang-Chou) n° 00065, female 520 mm TL.

Anacanthobatis donghaiensis (Deng, Xiong & Zhan, 1983)

Springeria donghaiensis Deng, Xiong & Zhan, 1983 : 212 (in Chinese), 216 (in English), fig. 2 (East China Sea).

Holotype : East China Sea Fisheries Institute n° SH80D-0371, female 325 mm TL.

BIOGEOGRAPHY : (Fig. 8)

So far the Anacanthobatidae occur within three well separated areas : the western Central Atlantic, the south-western Indian Ocean and the China Sea. The northern and southern limits of their distribution are 30°N (East China Sea, and northern Gulf of Mexico) and 30°S (Natal, South Africa). It is likely that the development of deep trawling around the world will bring further records of anacanthobatid skates, and so extend our knowledge of their distributions. Hulley (1972, 1973) suggested that the anacanthobatids might have spread from the western Central Atlantic, but this opinion has to be reconsidered since the South China Sea seems to be another centre of dispersion, and furthermore vicariance biogeography might as well be summoned to explain this distributional pattern. What are the relationships between the species of the south-western part of the Indian Ocean and those of the Atlantic and Pacific centres ? Although the present data do not allow a cladistic analysis, the overall similarities seem to indicate more recent shared ancestries between the SE African species and the Chinese species than either has with the western Central Atlantic ones.

Crurirajidae, the sister group of Anacanthobatidae (McEachran, 1984 and pers. com.) show a similar distributional pattern, i.e. the eight nominal species of *Crurirajа* occur within three well separated areas : western Central Atlantic, SW Indian Ocean (off South Africa) and Andaman Sea (India). Also the *Gurgesiella (Fenestraja)* group of skates exhibits a similar disjunct pattern :western Central Atlantic, SW Indian Ocean (off Madagascar, Seret, in press), and Bali Sea (Indonesia).

The SW Indian Ocean might well be a migratory route between the Indo-West Pacific and the Atlantic Ocean, as has already been assumed for skates (Stehmann, 1976) and other families of fishes (Smith, 1949). Or the western Central Atlantic species might as well have dispersed from a pool of south-western Indian Ocean species when the Atlantic Ocean opened in the late Cretaceous. If the latter is the case, the most derived fauna of all three groups should occur in the western Central

Atlantic. At the present level of our knowledges on Anacanthobatids, these hypotheses cannot be tested, pending on additional material and data.

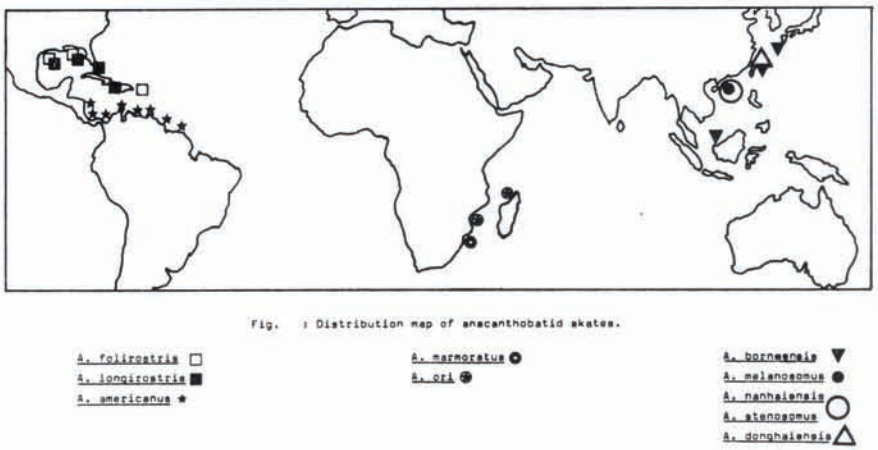

Fig. : Distribution map of anacanthobatid skates.

Fig. 8.– Distribution map of anacanthobathid skates.

Anacanthobatis folirostris — *Anacanthobatis longirostris*

Anacanthobatis americanus — *Anacanthobatis marmoratus*

Anacanthobatis ori — *Anacanthobatis borneensis*

Anacanthobatis nanhaiensis & *Anacanthobatis stenosomus*

Anacanthobatis melanosomus — *Anacanthobatis donghaiensis*

HABITAT

Anacanthobatid skates inhabit the continental slope. In the western Central Atlantic, the depths of collecting are ranging from 200 to 1100 m, with a single record of *Anacanthobatis americanus* at 51 m depth off Columbia (data from MCZ's catalogue). The Chinese species were collected between 475 and 1000 m depths. The South African *A. marmoratus* was trawled between 230 and 320 m depths. Its sympatric congener, *A. ori*, is the deepest species with a range of 1510-1601 m for the type-specimens, and 1000-1725 m for the Malagasy specimens. The nature of the bottom (reported for only 3 species) varies from soft mud to sand.

SIZE

Anacanthobatis are small-sized skates, the biggest specimen is a female of *A. longirostris* of 745 mm TL (MCZ n° 47805, from off northern Haiti). A mature female of 594 mm TL and a mature male of 551 mm TL are reported for *A. borneensis*, *A. stenosomus* is only known from the holotype, a female of 520 mm TL. *A. americanus* is mature at about 330 mm long (male), and *A. marmoratus* at 233 mm. The reported male of *A. nanhaiensis* seems to be semi-adult at about 300 mm TL.

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